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Thermally stimulated conductivity in (Ba:Sr)SO_4 phosphors

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The phosphors of $BaSO_4$, $SrSO_4$ and (Ba : Sr)SO_4 are prepared using bismuth as an activator. TSC plots are recorded with uniform heating rate (0·44°K/sec.) in the temperature range of 300°K to 540°K The effect of percentage composition on the peak intensities in the mixed phosphors is investigated.

1. Introduction

Since alkaline earth sulphate phosphors have gained significance in TL dosimetry, a large number of papers have appeared in the recent years (Luthra & Gupta 1974, Pradhan *et al* 1975, Nambi *et al* 1974). However these studies are confined to their thermoluminescence behaviour and spectral studies, and very little attention has been paid to their thermally stimulated conductivity (TSC) behaviour. In a photoconductor, electron reach the recombition centres from the traps via the conduction band. Thus the process of thermoluminescence (TL) would be accompanied by a change in conductivity of the phosphors which is known as thermally stimulated conductivity (TSC). Therefore TSC technique which is relatively simple than thermoluminescence, can be used to compute various parameters such as activation energy, population of traps, relaxation times etc. Recently this technique has been used by Rajendar & Bhatnagar (1975) for electro study. In this paper we report the TSC studies carried out on (Ba : Sr)SO_4 phosphors activated with bismuth.

2. Experimental

Phosphors were prepared by firing $BaSO_4$, $SrSO_4$ (G.R. Grade) together in various weight percentages alongwith desired bismuth subnitrate solution, at about 300°C for five hours. Details are described elsewhere (Pawar & Lagare 1976). Nevertheless, the following points are worthmentioning : Pure $BaSO_4$ and $SrSO_4$ are not visibly luminescent. But heat treated samples are X-ray fluorescent. The crystal structure of mixed phosphors is complicated as seen by X-ray diffraction patterns.

The measurement of TSC have been made in the temperature range of 300°K to 540°K. A fixed quantity of phosphor was spread over a thick copper disc acting as one electrode. The second electrode of cooper was placed above the phosphor. The sample was heated by a heating coil above which a mica

sheet was placed to provide the electrical insulation. To ensure a good electrical contact between the electrodes and the sample a fixed load was put up over a upper electrode. The whole assembly was enclosed in a light tight box. The samples were irradiated for one hour with CuK_α X-rays. The sample was heated at a constant heating rate (0·44°K/sec.) and resulting current was fed to a sensitive d.c. micrometer type 104A.

2. Results and Discussion

Figure 1 gives the TSC plot of 100% $BaSO_4$ phosphor. It consists of mainly two peaks lying at about 360°K and 500°K. The first peak is relatively less intense than the other. Similarly the TSC plot of 100% $SrSO_4$ phosphor is shown

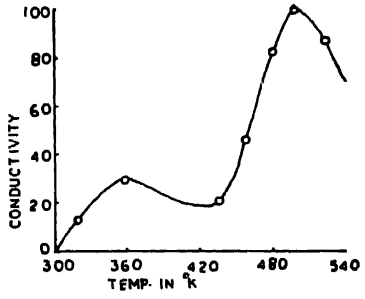

Fig. 1. TSC plot for 100% $BaSO_4$ phosphor.

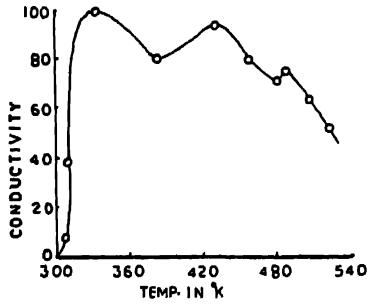

Fig. 2. TSC plot of 100% $SrSO_4$ phosphor.

in figure 2. In this plot there are mainly three peaks lying at about 325, 420 and 490°K. The peak heights are relatively decreased with increase of their peak temperatures.

Figure 3 represents the typical plot of mixed phosphors (sample No. 3, table no. 1). It consists of four overlapping peaks lying at about 325, 360, 420 and 490°K. It appears that it is exactly the combination of the peaks of $BaSO_4$ and $SrSO_4$ phosphors.

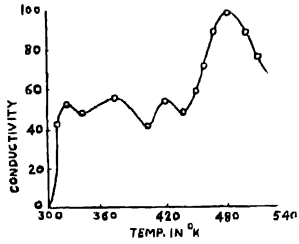

Fig. 3. TSC plot of mixed phosphor

The effect of percentage composition of $SrSO_4$ and $BaSO_4$ in mixed phosphors is systematically investigated. The intensities of the peaks lying at about 325, 360, 420 and 490°K are denoted respectively by I_1, I_2, I_3 and I_4 and are listed in Table 1. As the peak intensity is a relative measure of the population of traps, the quantitative information can be obtained from the data in Table 1. It seems that there is a strong group of traps associated with a TSC peak lying at about 325°K in $SrSO_4$ phosphors. As the percentage composition of $SrSO_4$ in mixed phosphors decreases, the peak intensity also decreases. Similar behaviour is observed for the $BaSO_4$ peak lying at about 490°K. However, for the peaks lying at about 360°K and 420°K no systematic behaviour is observed.

Table 1. T S.C. peaks and their relative intensities in arbitrary units

Sample Number	Wt. Percentage		Peak intensities			
	$BaSO_4$	$SrSO_4$	I_1	I_2	I_3	I_4
1	100	0	—	30	—	100
2	75	25	45	66	57	100
3	50	50	52	55	53	100
4	25	75	100	—	—	86
5	0	100	—	—	93	75

From the TSC curve, the activation energy can be estimated in several ways (Shalgaonkar & Narlikar 1972). However, in the present investigation as there are more than one peak observed, a relatively simple and well known

method due to Urbach (1946) is used to investigate the activation energies. According to Urbach,

$$E = 25KT_m$$

where K is the Boltzmann constant and T_m is TSC peak temperature. The value of E, thus calculated for T_m = 325, 360, 420°K and 490°K are found to be 0·69, 0·77, 0·90 eV and 1·05 eV respectively.

Acknowledgment

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